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SWEET CLOVER.

BY

J. M. WESTGATE,
Agronomist in Charge of Clover Investigations, Bureau of Plant Industry.

AND

H. N. VINALL,
Assistant Agrostologist, Bureau of Plant Industry.

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., January 4, 1912.

Sir: I have the honor to transmit and to recommend for publication as a Farmers' Bulletin the accompanying manuscript entitled "Sweet Clover," prepared by Mr. J. M. Westgate, Agronomist in Charge of Clover Investigations, and Mr. H. N. Vinall, Assistant Agrostologist, both of the Office of Forage-Crop Investigations of this Bureau.

The widespread discussion as to the merits and demerits of this plant has resulted in many conflicting statements regarding its value. Although frequently regarded as a troublesome weed, sweet clover seldom encroaches on cultivated land, while its value as a forage crop, as a soil renovator, and as a forerunner of alfalfa, in addition to its widespread utilization as a honey plant, makes it desirable to point out under what conditions its use is to be recommended and where its cultivation should be avoided, as well as to give instructions regarding the best methods of eradicating it when it is desired to utilize the ground in some other way.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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SWEET CLOVER.

INTRODUCTION.

The sweet clovers (*Melilotus alba* and other species) are among the oldest of known plants, but only within comparatively recent years has their value for forage come to be recognized even locally in this country. The bitter taste of its foliage and the tendency of its stems to become woody when mature have caused sweet clover generally to be deemed of little value as a forage plant, because under ordinary conditions stock refuse to eat it unless they have been led to develop a taste for it.

This plant is known by a number of other names, among which the most common are Bokhara clover and melilot or Melilotus. It is also called bee clover, honey clover, mountain clover, and galy-gumber clover. When reference is made to the yellow-blooming species the term "yellow" is generally prefixed to the common name, but when no qualifying term is used the white species is the one usually meant. This usage is followed in the pages of the present bulletin.

The utilization of sweet clover should be accompanied by a thorough understanding of the somewhat peculiar requirements for success with this crop, as well as a knowledge of the conditions under which it may prove troublesome as a weed. It is of so much value when rightly utilized that its extension where it will not prove a menace should be encouraged by every legitimate means. Its value as a honey plant has long been recognized, but its efficiency in increasing the fertility of run-down soils is less widely known. Its utilization as a pasture, hay, and soiling crop is even yet practiced only locally throughout this country, but the extent of such utilization is steadily increasing. The fact that the bacteria on its roots are capable of inoculating alfalfa makes it a valuable crop to occupy the land immediately before seeding alfalfa. The sweet clover not only inoculates the soil but the large roots do much toward breaking up and aerating the subsoil, a condition which is very favorable to the growth of the alfalfa plants.

The tendency of sweet clover to occupy vacant land is noteworthy. It is often seen on vacant city lots and along roadsides and fence rows.

It does not usually encroach on cultivated fields nor on meadows that are regularly mown for hay. Stock often refuse to eat it at first on account of its bitter taste and strong odor, but when once induced to eat it by sprinkling it with brine or by other means they apparently relish it as much as any other forage and many animals show a preference for it.

DIFFERENT SPECIES OF SWEET CLOVER.

A great number of different species of sweet clover have been more or less utilized, especially in the Old World; but only three species are at all abundant in this country. These species (fig. 1) are the white biennial sweet clover (*Melilotus alba* Lam.), the large yellow biennial sweet clover (*Melilotus officinalis* Lam.), and the small yellow annual sweet clover (*Melilotus indica* All.).

FIG. 1.—Seeds and seed pods of three species of Melilotus: *a*, *Melilotus alba* (white sweet clover); *b*, *Melilotus officinalis* (large yellow biennial sweet clover); *c*, *Melilotus indica* (small yellow annual sweet clover). The small figures in each drawing show the natural size of the seed.

ORDINARY WHITE SWEET CLOVER.

The ordinary white sweet clover is commonly referred to merely as sweet clover. When the yellow-blooming strains are meant they are usually referred to by the color of the flowers. Some progress has been made toward the development of less bitter strains of the white sweet clover, but these are not yet sufficiently distinctive to warrant trade names. The accompanying illustrations (figs. 2 and 3) indicate the general appearance of the white sweet-clover plant. It is an erect, stemmy, branching biennial plant with uniform, ascending stems not thickly supplied with leaves. During its second season it makes a growth of from 5 to 12 feet, produces numerous flowers, and dies when it has matured its seed. The first season it makes a growth of 18 to 30 inches in height and in addition stores up in a very large root reserve food material for a rapid and vigorous growth early the following season (fig. 4). When young the plant resembles alfalfa but can readily be distinguished by the bitter taste of its foliage. When in bloom it can easily be identified by the long, loose racemes of white flowers and its open coarser growth (figs. 3 and 5).

Unlike alfalfa the seeds are borne singly in each pod (fig. 1*a*). In common with other legumes it possesses the power of storing up nitrogen in the nodules on its roots, thus adding one important element of soil fertility to the land on which it is grown.

FIG. 2.—Sweet-clover plant at the end of the first season's growth.

LARGE YELLOW BIENNIAL SWEET CLOVER.

The large yellow species is carried on the market under the name of yellow sweet clover. Like the ordinary white sweet clover it is a biennial. It is more spreading in habit and does not grow as tall as the white sweet clover, but attains a height of 3 to 5 feet. Owing to this more decumbent habit it is apt to be more of a pest in meadows, since the mower passes over a portion of the plant, which thus remains to produce seed and reseed the land. This species blooms one to two weeks earlier than the white sweet clover and is often used to supplement it for bee pasturage.

SMALL YELLOW ANNUAL SWEET CLOVER.

The small yellow species is a low-growing, erect, early-flowering plant. It is only an annual, whereas the two species already described are biennials. It makes very little growth, at least in the sections where the other two sweet clovers are usually produced, and is not considered of much value. It is well thought of in southern California, but is not recommended for sections where the other species are perfectly adapted. Some confusion in the seed trade during recent years has been caused by the substitution of this small yellow annual sweet clover for the large yellow biennial sweet clover

(*Melilotus officinalis*). The differences in the seed and seed pods are indicated in figure 1. The Seed Laboratory of the United States Department of Agriculture, Washington, D. C., will identify samples

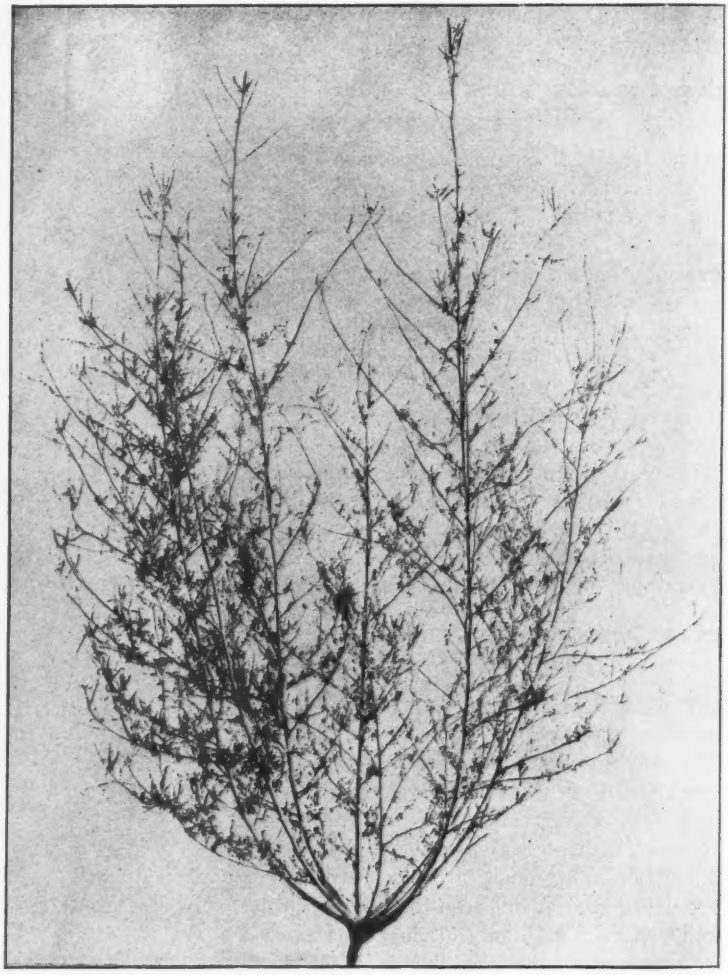

FIG. 3.—Sweet-clover plant near the close of the second season's growth.

of these different species at any time without charge. It will be noted that the seed of the small annual yellow sweet clover has a rough surface while the seeds of the other yellow species are smooth. This species makes a vigorous growth under subtropical conditions.

HISTORY AND PRESENT DISTRIBUTION OF SWEET CLOVER.

The sweet clovers are natives of central Asia and have been known for more than 2,000 years to grow in the Mediterranean region of the Old World, where they have been utilized as honey plants as well as for forage and green manures. They are now distributed over the entire civilized world, usually occupying waste places not otherwise utilized. The white sweet clover was introduced into the United States by European colonists as early as 1738, but its value has not been recognized to any appreciable extent until within the last 20 years. It is at present grown extensively as a field crop in Alabama, Mississippi, Kentucky, and Utah, and locally on a field scale in Nebraska, Colorado, Wyoming, Iowa, Wisconsin, Illinois, Indiana, and Ohio. The accompanying map (fig. 6) indicates the sections where it has been definitely reported to be successfully utilized as a forage crop. It is looked upon as a troublesome weed in a number of States, especially in New York and in the irrigated States of the West, where it is spread over the alfalfa fields by the irrigating waters. The sweet-clover plants grow luxuriantly on the ditch banks and drop their seed into the irrigating ditches. The spreading of this plant into all parts of the country has been hastened by the seeding of it in waste places by beekeepers for the production of honey. This practice has often been condemned by those not interested in bees on the ground that the behavior of the plant is that of a noxious weed.

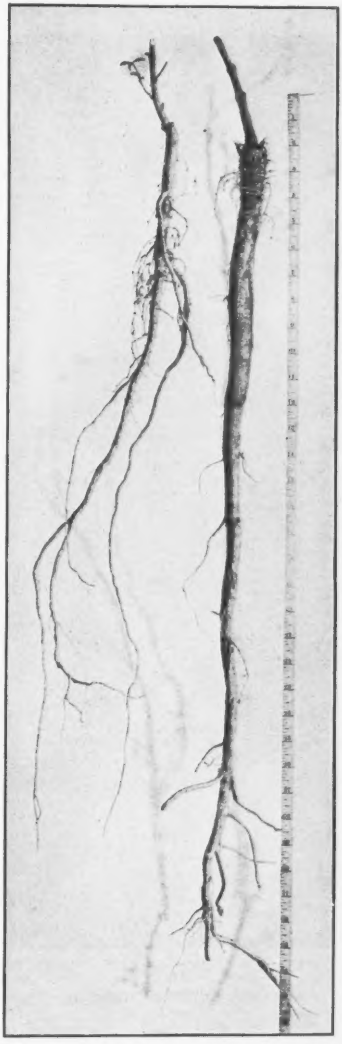

FIG. 4.—Sweet-clover roots showing enlargement at the end of the first season's growth. Buds for second season's growth already formed.

ADAPTABILITY OF SWEET CLOVER TO VARIOUS SOILS AND CLIMATES.

Sweet clover grows in all parts of the United States. It apparently possesses a wider adaptability in regard to soil types and climate than any of the true clovers and probably wider than alfalfa.[1] It succeeds in the extreme southern portions of the country and also grows vigorously in the Northern States, where it is called upon to endure great extremes of temperature. It thrives in the most humid parts of the country as well as in the semiarid regions, where the rainfall is but three-fifths of that required for the normal growth of such crops as timothy and red clover. It produces satisfactory crops on the "acid" soils of the Eastern States and also on the alkali soils of the West where sufficient alkali is present to prevent the growth of most farm crops. It will grow on soils too sandy to support ordinary field crops and appears to be even better adapted to raw clay and loess cuts and fills, where scarcely any other vegetation is able to establish a foothold (fig. 7). It also makes an excellent growth in gravel pits and stone quarries, but for some reason does not seem to do well on unsettled, cultivated soil. It makes its best growth where the soil is compact and not crowded with other vegetation.

FIG. 5.—Portion of a sweet-clover plant showing flowers and different stages in the seed development.

[1] See Farmers' Bulletin No. 339, entitled "Alfalfa," by J. M. Westgate.

In such States as Iowa it seems to require a rich soil for satisfactory growth, but on the limestone hills of the Eastern and Southern States it makes a good growth on soils too poor to produce a paying crop of corn.

The adaptability of sweet clover to such an extreme range of conditions permits it to be recommended for utilization when the more valuable leguminous forage crops such as alfalfa and red clover[1] can not for any special reason be successfully produced. Its drought resistance makes it valuable for semiarid sections where irrigating water is not available, and in such of the Southern States as are

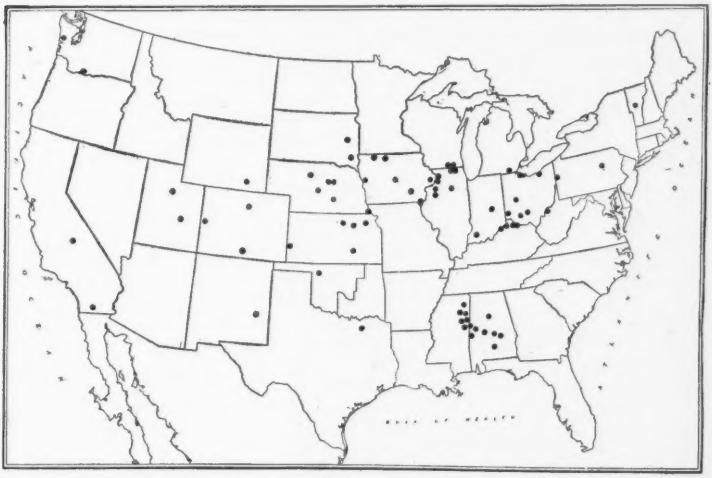

FIG. 6.—Map showing some of the localities where sweet clover is being utilized as a forage crop.

characterized by occasional severe droughts it exceeds such plants as Lespedeza, or Japan clover, in ability to withstand these dry spells.[2]

REQUIREMENTS FOR OBTAINING A STAND OF SWEET CLOVER.

A great many farmers have noted the luxuriant growth of sweet clover along roadsides and in other uncultivated places where it grows without any special attention, but have often been disappointed by obtaining a very inferior stand when seeding it upon cultivated land. For this reason it is necessary to look rather closely into the requirements for obtaining and maintaining a successful stand of this crop.

[1] See Farmers' Bulletin No. 455, entitled "Red Clover," by J. M. Westgate and F. H. Hillman, and Circular No. 80, Bureau of Plant Industry, entitled "Forage Crops for the Sand-Hill Section of Nebraska," by H. N. Vinall.

[2] See Farmers' Bulletin No. 441, entitled "Lespedeza, or Japan Clover," by A. D. McNair and W. B. Mercier.

SOILS ADAPTED TO SWEET CLOVER.

Almost any reasonable well-drained soil will grow sweet clover. It is more tolerant of poor drainage, overflow, and seepage conditions than alfalfa or red clover. In irrigated sections, especially where the reservoir system is in use, large bodies of land are apt to become useless for ordinary crops on account of the rising of the water table in the near-by fields. On such areas sweet clover has been observed to make a very vigorous growth. It is about equal to alsike clover in its ability to withstand poor drainage, but is less indulgent than either redtop (*Agrostis alba* Lam.) or slough grass (*Spartina michauxiana* Hitchc.). It makes its best growth on rich well-limed ground, but will make satisfactory growth on very poor limestone soils. It succeeds on newly exposed clay soils that presumably lack lime, but does not spread rapidly in clay soils outside of the limestone sections. When wanted for hay it will usually pay to seed it on fairly good soil, but for pasture the poorer fields of the farm can be made to yield returns that will justify the utilization of this crop upon them. Its value comes not only from the pasture obtained but also from the improvement resulting to such poor soils, especially if they be of limestone origin. After a few years in sweet clover, during which considerable pasture can be utilized, the ground will be brought into much better conditions for cultivated crops than it was before the sweet clover was established. Where not pastured too heavily a fair seed crop can often be obtained without seriously retarding the plant in its work of building up the fertility of the soil. On very poor soils the stand is often thin at first, but ordinarily

FIG. 7.—Sweet clover on a steep slope along the roadside.

it thickens up as the soil becomes richer and better able to support a good growth.

PREPARATION OF THE SEED BED FOR SWEET CLOVER.

Sweet clover requires a thoroughly compacted seed bed with just enough loose soil on top to enable the seed to be covered. The lack of a solid seed bed is probably the chief reason why sweet clover so often fails when seeded upon cultivated fields. The success of the crop on poor hills from which practically all the soil has been removed by erosion and on newly exposed clay areas where the ground is extremely hard and compact is thus explained. One field in northern Virginia sown on a loose seed bed heaved out almost completely in the spring of 1911. When a field which has been in cultivation is to be seeded to sweet clover it should be more thoroughly firmed and better settled than if intended for other crops. Plowing, if necessary, should be done several months before seeding, but it is usually best to seed on ground such as corn stubble that does not require plowing and depend on a disk, a turning and slicing harrow, or a spike-tooth harrow to cover the seed. In the East and South where the rainfall is abundant, it is well to roll the ground after seeding. Tests to determine proper dates of planting have indicated that successful stands can be obtained in Virginia by seeding either about the middle of May or the middle of August, and though it is possible that late winter seeding upon ground honeycombed by frost will prove practicable there is a lack of data on this point. The early germination rendered possible by such procedure seems to be in accord with the requirements for the best development of the plant during its first season's growth. Sweet clover has been seeded successfully with spring-sown grain as a nurse crop, but this method is probably open to some objection by reason of the somewhat loose, unsettled seed bed usually present under such conditions.

Seeding with a nurse crop of grain, however, contemplates the use of sweet clover in rotations and not as an individual crop. Where it is desired to obtain the maximum returns from the sweet clover itself in pasture, hay, and seed it is best seeded alone on a well-prepared but very firm seed bed. Then, if sown in early spring, it can be pastured with hogs or cattle the first year and the second year it may be expected to produce its maximum growth, furnishing both early pasturage and a hay or seed crop.

FERTILIZERS FOR SWEET CLOVER.

It is not usually necessary to apply any sort of fertilizer to the ground upon which sweet clover is to be seeded. Its success on the limestone hills, in stone quarries, etc., would seem to indicate the need of lime in the soil. Its successful growth, however, on soils

that undoubtedly are deficient in lime shows that liming may not always be necessary. Sweet clover will probably respond favorably to the regular commercial fertilizers, but owing to the ability of this crop to succeed on many poor soils, especially those of limestone origin, it is probably the better practice to hold the fertilizer and apply it to the cultivated or money crops which follow the sweet clover. No information concerning the use of fertilizers on sweet clover in this country is available.

SEEDING SWEET CLOVER.

Under natural conditions the sweet-clover seed germinates for the most part in early spring, although a few seedling plants may also be observed in the late fall. Early spring seeding has been satisfactory in many sections, especially where the seed is sown on land not freshly plowed. When sown on ordinary cultivated fields sweet clover is usually sown later in the spring and often with a nurse crop of spring-sown grain. It has also been successfully seeded with such crops as fall wheat or rye, the sweet-clover seed being scattered in the spring in the same manner as red clover is frequently seeded. Fall seeding of sweet clover is also successful in regions of mild winters and can well be resorted to if it is desirable that the land be occupied through but one growing season. The lack of root development the first fall, however, reduces to some extent the growth of the crop the following season, and this may prove too much of a handicap to be offset by the other advantages. It usually requires 20 to 30 pounds of hulled seed and at least 5 pounds more of unhulled seed per acre. A lesser weight of seed would be sufficient were it not for the fact that often one-half of the seed has such hard seed coats that it does not germinate the first season and therefore is practically useless. This retarded germination of the hard seed can be overcome by soaking the seed in commercial concentrated sulphuric acid for half an hour. It should then be quickly washed, using running water if possible, as sulphuric acid becomes very hot when mixed with a small proportion of water. A great deal of water is therefore necessary in order to lessen the danger of burning. The seed should then be dried off quickly by spreading it out on a floor or canvas and stirring at intervals.

The acid corrodes or eats away the hard impermeable seed coat sufficiently to enable the seed to absorb enough moisture to germinate. This method has been investigated by Prof. H. L. Bolley, of the North Dakota Agricultural Experiment Station, and by Dr. H. H. Love and C. E. Leighty, of the New York (Cornell) Experiment Station.[1] Tests made in the Department of Agriculture gave an in-

[1] Bulletin No. 312, Cornell University Agricultural Experiment Station, 1912.

crease in germination of 40 to 45 per cent. Great care must be exercised when working with sulphuric acid, as it burns the flesh and any wooden objects badly and is especially dangerous to have around in the presence of children. The vessels used for treating the seed should be of earthen or enameled ware to prevent corrosion by the acid. After the seed is treated it should preferably be sown promptly as it has a tendency to dry out after the coat has been eaten off by the acid, but it can be held for two weeks or a month under favorable conditions without any considerable deterioration. This method is still in the experimental stage and many details presumably remain to be worked out in actual practice. The imported seed is always hulled, while that grown in this country may not be hulled, owing to the fact that it is often gathered by hand locally and usually in a quantity too small to make it practicable to have it run through a huller. When starting a permanent pasture it is best to seed two years in succession at first, in order that there may be a number of 1-year-old plants ready to take the place of the 2-year-old plants which mature seed and die.

Hard seed is present in nearly every sample, but is more abundant in southern-grown than in northern-grown seed. In commercial samples the proportion sometimes runs as high as 90 per cent. The lesser proportion in imported seed than in either the native northern or southern grown seed is possibly due to the fact that much of the imported seed is more than 1 year old. Table I shows the percentages of hard seed found in samples of sweet clover from different sources.

TABLE I.—*Percentages of hard seed found in sweet clover from different sources.*

Source of seed.	Number of samples.	Average per cent.	
		Germination.	Hard seed.
Southern	22	14	60
Northern	22	37	43
Imported	28	56	12

The following methods of obtaining a stand of sweet clover in northeastern Iowa are described in a letter from Mr. Frank Coverdale, of Delmar, Iowa:

A field of grass sod should be plowed in the fall and disked as in preparation for a corn crop. The first week in May, 20 pounds of hulled sweet clover per acre should be sown and harrowed in well. This seeding may be done as soon as the ground is sufficiently dry early in the spring, but in this section best results have come when sown at the above date.

Another good method of securing a stand is to sow it with some small-grain crop which can be taken off early in the summer. Barley or Early Champion

oats may be used as a nurse crop. When sweet clover is sown with such a nurse crop the young sweet-clover plants will be of considerable size by the time the grain should be cut, and on this account it is well to cut the grain as high up from the ground as possible.

Still another method is to take a small-grain crop off the land as early as possible, plow and disk immediately, and then seed the sweet clover not later than the last week in July. Plants from seed sown the second week in August have failed to live through the winter, but where there is plenty of moisture in the soil sowing the last week in July has resulted splendidly. Sweet clover acts very much the same as red clover and alsike; like them, if sown after August 1, it is likely in this latitude to fail to live through the winter. Even when sown as late as the latter part of July failure is likely to result unless there is plenty of moisture in the soil. This method, therefore, is not to be depended upon in a dry season. Seeding sweet clover in corn at the last cultivation gives fair results if the stand of corn is not too thick and rank in growth. This method, however, is not to be relied upon as a general rule and has not given very satisfactory results.

Everything considered, sweet clover does best when sown alone. For the very best results with this crop a fertile piece of ground should be selected. Limestone land is specially favorable for sweet clover. It is not absolutely necessary to utilize grass or clover sod, but it is necessary to have the ground reasonably rich and free from weeds if a strong stand is to be obtained.

After sweet clover is planted on a farm and the bacteria get established in the soil a stand will be less difficult to secure. When a few farmers first sowed this clover in this vicinity none succeeded in getting a catch, but this year almost all who used proper methods are succeeding in spite of the severe drought. My stand of sweet clover which was sown on sod land is all that could be desired. The sweet clover on the wheat land, however, is thin because the wheat sapped the moisture from the ground. Some of my neighbors inform me that sweet clover sown on oats has come through in good shape. There is more to the successful growth of sweet clover than most people think.

INOCULATION OF SWEET CLOVER.

It is apparently very essential that the sweet-clover plants be well inoculated if they are to produce satisfactory results. This inoculation is often naturally present, owing to the growth of sweet clover along the roadsides and in fence corners. Where the washing from such patches is distributed over the field the proper bacteria may be reasonably assumed to be in the field without further attention. In any event it is usually not difficult to use soil from around the roots of such sweet-clover plants for inoculating the field. Such a procedure is generally to be recommended.

THE SOIL-TRANSFER METHOD OF INOCULATION.

Inoculation by the soil-transfer method is generally more certain in its results than the pure-culture method, but where the soil is brought in from some outside locality not known to be free from noxious weeds, insect enemies, and plant diseases there is danger of introducing such pests.

The soil-transfer method consists in scattering over the new ground at the rate of 200 to 300 pounds to the acre soil from a healthy sweet-clover field, where the plants show an abundance of the tubercles on their roots. It is suggested that the seed be mixed with a small portion of the soil and the remainder drilled or scattered broadcast and immediately harrowed in. This should be done preferably on a cloudy day or toward evening, as the sun's rays are very injurious to the germs; but if the person who scatters the soil walks directly in front of the harrow the sun has practically no opportunity to harm the germs. To facilitate even scattering, the soil may be mixed with two or three times its own weight of ordinary soil obtained close at hand to save carriage charges.

A comparatively new method which, wherever tried, has given successful results, calls for the dampening of the seed and the spreading of it on a cloth, paper, or cement floor where an equal amount of soil from sweet-clover or alfalfa plants can be sifted over it. The dampened seed catches the soil and as soon as the seed is sufficiently dry to sow it should be seeded. This has the advantage of requiring only a small amount of soil and apparently assures satisfactory results. Another method is to make a soil solution of the inoculated soil and dip the seed in this before sowing.

THE PURE-CULTURE METHOD OF INOCULATION.

The pure-culture method, though considerably less certain than the soil-transfer method, has the advantages of greater ease of transportation and freedom from danger of introducing harmful pests upon the farm. The method of inoculation by pure cultures may be carried out in either of two ways: (1) A bottle of pure culture of the proper kind of bacteria is opened and the culture mixed with a convenient quantity of water; this diluted culture is now thoroughly mixed with a considerable quantity of soil, preferably from the field where the legume is to be sown; the treated soil is then distributed in the same manner as when inoculation is made by the use of soil from an old field; (2) a pure culture of the proper kind of bacteria is prepared according to the directions accompanying the bottle and is then applied to the seed in such a way that all of the seed may be moistened, though not soaked. The seed should be planted as soon as practicable after this treatment—that is, as soon as it is sufficiently dry for convenient handling. Drying may be facilitated by adding dry, sifted earth, preferably from the field in which the leguminous crop is to be grown. The nodule bacteria very often die within a week after the seed is inoculated and dried; it is therefore highly desirable that the inoculation be made the same day the seed is sown. Inoculated seed should never be dried in the sun.

TREATMENT THE FIRST SEASON.

When seeded in the spring without a nurse crop no special treatment is required the first season, unless it is necessary to cut back any weeds which threaten to choke out the sweet-clover plants. This clipping should be at a height of 5 or 6 inches and will induce the sweet-clover plants to stool out instead of producing a slender plant the first season. The stand may be pastured during the first summer and in the fall until a number of killing frosts have occurred. If the pasturing is not sufficient to keep the young plants eaten back a cutting of hay should be made when the growth ceases in the fall. It is apparently not necessary to allow any of the top growth to remain on the plants when they go into the winter.

When seeded with a nurse crop such crop may be cut for grain if the moisture conditions are favorable, but if an untimely drought threatens the life of the sweet-clover plants the crop should be cut for hay. In the South a good hay crop or late summer pasture may be obtained the first season even when sown with a nurse crop, but in the North a small amount of late pasture only is usually available.

TREATMENT THE SECOND SEASON.

One of the special advantages of sweet clover is its very early growth in the spring, producing good pasturage before other pasture crops have commenced growth. In the North it will furnish a good hay crop in the latter part of June and a second crop of hay or seed in the late summer. In the South two crops of hay and one of seed may be harvested the second season. After maturing seed the plant dies, even though it be only the first cutting of the second season's growth that is allowed to mature seed. Sweet clover may also be pastured the entire season, and if not pastured too heavily will reseed itself for succeeding seasons. It is often a desirable practice to mow off the heavy growth so as to induce new growth which will be more readily eaten by the stock. If this is done narrow strips of uncut plants should be left at intervals for the purpose of reseeding the pasture.

NEED OF EXPERIMENTS WITH SWEET CLOVER.

Many points in connection with the production of sweet clover yet require experimental determination. Needed knowledge can best be gained by a comparison of the relative merits of different practices, so that questions regarding specific points may be definitely answered. The special requirements of the sweet clover on any particular soil type or in any particular section is a matter which must usually be determined by direct experiment. By devoting a small section of the field to experimental purposes these needs can readily be deter-

mined. Among the points which can be experimented with on narrow strips across one end of the field are: Time of seeding, rate of seeding, and the merits of a nurse crop as compared with no nurse crop. At right angles to the narrow strips upon which the different times of seeding, etc., are being tried it is entirely practicable to apply different amounts of lime in order to determine the effect of different rates of application of lime upon each of the other experiments being tried. Later in the season strips across the regular field may be cut at different stages of growth to determine the effect on the suceeding crops of hay or seed. In all such experimental strips it is important to provide a check strip to be given only the customary treatment. This will serve as a basis of comparison for the different treatments given on the experimental plats. The combination of methods giving the most promising results can be applied to a much larger acreage the succeeding season.

USES OF SWEET CLOVER.

The nature of sweet clover permits of its being utilized in a number of different ways. For forage purposes it may be used as hay, as ensilage, as a soiling crop, or as pasture for all classes of live stock, which may be readily taught to eat it. It may also be used as a green-manure crop.

It is especially valuable as a honey plant, furnishing nectar for bees over a long season. It is often seeded in waste places for bee pasture and is the only plant now known to beekeepers which can be utilized in this way with profit. The honey made from sweet clover is darker than that from white clover and has a decidedly greenish color. When it is unmixed with other honeys the flavor is not usually considered the finest, but it is usually found mixed with white clover, alsike, alfalfa, or other honeys, in which case the characteristic flavor is pleasing. Blooming as it does after the white-clover honey flow, sweet clover is a valuable asset to the beekeeper. Of recent years sweet-clover honey has appeared in considerable quantity on the market from various parts of the country. Its utilization as a honey plant dates from remote antiquity and to this feature of the plant is due the name "Melilotus," which means honey lotus or honey plant.

It was also used by the ancients in medicines, and to a certain extent this use is continued to the present day. Its utilization as a forage crop and as a soil improver will be considered more in detail

SWEET-CLOVER HAY.

In the absence of more valuable forms of hay sweet clover may be utilized for feeding all classes of live stock. In the North one cutting is usually possible the first season, especially if seeded with-

out a nurse crop, and two cuttings may be obtained the second year. In the South two cuttings the first season and three cuttings the second season are ordinarily possible. The Massachusetts State Experiment Station seeded a plat of sweet clover May 8 and on September 9 it was cut, yielding cured hay at the rate of 2,700 pounds per acre. The following season a cutting was made on June 24, yielding at the rate of 2,727 pounds per acre, and on September 22 a second cutting yielded at the rate of 1,000 pounds per acre. At the Canebrake substation, Uniontown, Ala., in 1904, the first year's seeding of sweet clover produced hay at the rate of 5,056 pounds per acre, and in 1905 the second season's crop was 6,320 pounds per acre. Another plat produced 6,672 pounds per acre in 1903 and 7,048

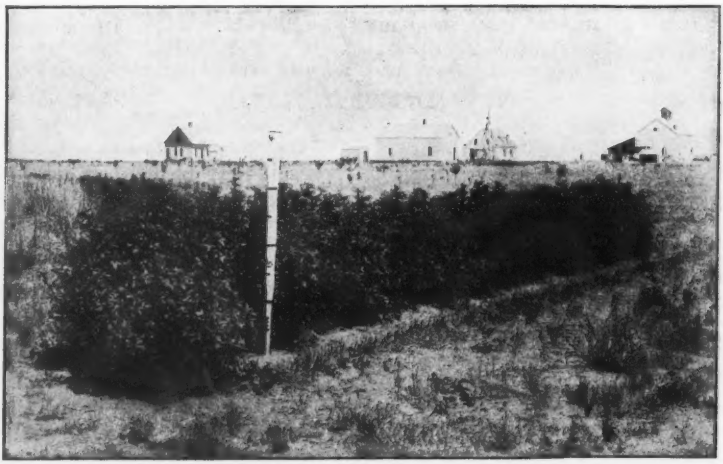

FIG. 8.—Row of sweet clover at Akron, Colo., showing proper stage for cutting. Annual precipitation approximately 19 inches.

pounds per acre in 1904. At the Utah Experiment Station in 1892 sweet clover made more than double the yield of any of the clovers or grasses with which it was compared.

TIME OF CUTTING SWEET CLOVER FOR HAY.

The first season's growth does not usually get coarse and woody and should be cut when it shows its maximum growth in the fall. It is not necessary to allow time for any second growth to come on before cold weather. The second season it is necessary to cut the hay before the first bloom buds appear, since after this stage the plant rapidly becomes coarse and woody and much less palatable to stock. (Figs. 3, 8, and 9.)

CURING AND HANDLING SWEET-CLOVER HAY.

When cut before blooming, the plants are rather succulent and hard to cure. In this respect it is often harder to cure properly than either alfalfa or clover, since by the time the large succulent stems are cured the leaves are very apt to shatter. The shattering of the leaves should be avoided, as the leaves constitute the best portion of the hay. The mower may be started in the morning as soon as the dew is off and the hay raked into windrows just before the leaves become dry enough to shatter. After allowing it to remain a day in the windrow it may be put into shocks and cured (fig. 10). These shocks should not be so large that they can not be thrown on the rack entire by the pitchers. If too large, the shocks must be torn

FIG. 9.—Sweet clover (S. P. I. No. 16289) growing at Bellefourche, S. Dak. Plants 6 feet high; annual precipitation approximately 16 inches.

apart when pitched on the rack, and this will result in a considerable loss of leaves. Sweet clover is not difficult to cure in the shock, and instances have been observed where it was shocked up perfectly green, in which condition the leaves dried so as turn water very readily.

Another method of haying is to cut two or three hours in the afternoon, stopping when the dew commences to fall; the plants then remain practically green overnight and the dew on top of the swath soon dries off in the morning, thus allowing nearly a full day for drying in the swath before starting the rakes in the afternoon. The hay may be stowed away in barns, but it is usually stacked. Some sort of foundation for the stack is always desirable to prevent the loss of the hay which otherwise would come next to the ground.

Some kind of covering for the stack should also be provided, either in the form of a roof, a canvas, or long-grass hay placed on top. If none of these means is practicable, a topping of perfectly green sweet-clover hay will cure with the leaves flat and turn most of the water. It is well known that hay made from either red clover or alfalfa will undergo spontaneous combustion if put into the barn with too much external moisture upon it. No instances of spontaneous combustion of sweet-clover hay have been reported, but this may be due to the fact that comparatively little sweet-clover hay is mowed away in barns. The same precautions should therefore be taken with sweet clover as with red clover or alfalfa hay.

FIG. 10.—Sweet clover in shocks for hay.

SWEET CLOVER AS A SOILING CROP.

When cut green and fed to cattle the sweet clover is usually less palatable than when fed as hay, although numerous instances have been noted where the freshly cut green feed has been readily eaten by stock. As a soiling crop it is best adapted for feeding to hogs. At the Ontario Experiment Station over 30 tons of green feed per acre were obtained in a single season.

SWEET CLOVER AS PASTURE.

Sweet clover makes excellent pasture for horses, sheep, cattle, hogs, and chickens (fig. 11). Probably the easiest way to create an appetite for the plant is to commence pasturing the stock on it very early in the spring before other green feed has started. A sufficient

number of animals should be kept on it to keep it eaten down close so that at all times there will be an abundance of fresh shoots for grazing purposes. An acre of sweet-clover pasture will ordinarily support 20 shoats, in addition to furnishing a light cutting of hay. For the best growth of the hogs, however, a pound of grain per hundredweight of the stock per day should be given. When pastured on the first season's growth of sweet clover it is well to place rings in the hogs' noses to prevent them from digging up the roots of the young plants. Grazing appears to be beneficial to the plants in that it induces stooling.

Stock when pastured upon sweet clover make gains which compare very favorably with those obtained from either alfalfa or red clover. The advantage which sweet clover has over the crops just men-

FIG. 11.—Hogs pasturing on sweet clover in Iowa.

tioned is that it will grow on some soils too poor in humus for the successful production of either alfalfa or red clover. A few cases of bloating of cattle have been noted when they were pastured on sweet-clover fields, but these cases are much less frequent than on red-clover or alfalfa fields. The best method of avoiding the slight tendency to bloat is to refrain from turning the stock on the sweet clover when it is wet with dew or rain or when the animals are unusually hungry for green feed. Most of the grazing of sweet clover is confined to regular pastures, but in an increasing number of localities roadside grazing is becoming common. In several sections sheep are reported to have obtained valuable sustenance from grazing on sweet clover, especially during droughts when the ordinary pastures were dried up. It is doubtful whether sweet clover will ever do more than supplement other pastures. Its chief advantages are its

ability to grow on and build up poor soils, to survive the midsummer droughts which frequently occur throughout the country, and to produce early and late pasturage.

SWEET CLOVER AS A FEED.

PALATABILITY OF SWEET CLOVER.

The chief drawback to the utilization of sweet clover is its bitter taste due to cumarin, which causes animals at first to refuse it. In this respect, however, it is only fair to the sweet clover to note that stock will often refuse to eat a number of valuable leguminous forage crops when first offered to them. Milk cows have been observed to refuse an entire ration of alfalfa hay even when no other feed was available at feeding time. This, however, was when it was first introduced to them. Shippers of cattle from the arid sections of the West, where corn is unknown, often have difficulty in getting the stock to eat corn fodder or even corn. One specific instance has come under observation where the cattle were fed corn with the dried husks attached, whereupon they ate off the husks and left the corn uneaten. When these same cattle were turned on the green grass the following season instead of eating the new growth they contented themselves with browsing off the dead stalks of the preceding season's growth, which presumably more closely resembled the desert grasses to which they were accustomed. Preliminary experiments with leguminous crops, even at the hands of careful experimenters, can not always be taken as final. In this connection it may be mentioned that when cowpeas were first tried in portions of this country it was found so difficult at first to induce stock to eat the vines, either when cured or made into ensilage, that even at a certain State experiment station the opinion was expressed that cowpeas were of no local value as feed for live stock. Subsequent developments proved that this crop has great possibilities even in the sections where the preliminary trials showed it to be very unpromising as a feed owing to the difficulty experienced in making stock eat the forage.

Much greater difficulty is usually experienced in inducing the stock to become accustomed to sweet clover than is the case with other legumes, but the fact that in at least half of the States in the Union stock have become accustomed to eat this plant indicates that the natural distaste which stock at first show can be successfully overcome.

Much effort is being given in several parts of the country to the development of a cumarin-free variety of sweet clover by selection and also by hybridizing it with smaller, less valuable species of sweet clover which do not have this bitter principle. Efforts are also being made looking to the introduction of less bitter strains from foreign

countries. These efforts may in time prove successful, but at present they are not so important as it is sometimes thought, since stock can be readily induced to eat the ordinary sweet clover, and once they acquire the taste for it no difficulty is thereafter experienced in getting them to eat all that they require. It is also held that the cumarin or bitter principle reduces the danger of bloating. Cumarin is well known to physicians and druggists and for thousands of years has been used as a corrective, tonic, and antiseptic in intestinal disorders. The sweet clover starts its growth about two weeks in advance of the other ordinary pasture crops and at this stage is not especially bitter. When the cattle are turned on it at this time they are hungry for any green feed and eat it from the first, practically without exception. Close pasturing or an occasional clipping with a mower will insure the continued presence of the fresh shoots, which will thus be available throughout the season. The hay when properly cured is seldom refused by stock, but if they should refuse it a sprinkling of brine on the hay when the animals are salt hungry is usually all that is necessary to induce them to eat it. The rank flavor of sweet clover has been held by some to taint the milk when eaten by milk cows, but this is disputed by those who have utilized it on an extensive scale. Whether or not there is some narcotic principle in the cumarin, it is a well-known fact that once stock are induced to eat sweet clover for a few days they become quite fond of it and will often leave other grasses and clovers to eat it. Its palatability, and probably also its digestibility, decreases with the age of the plant and for this reason it should be utilized at as early a stage as is practicable.

COMPOSITION OF SWEET CLOVER.

In common with other legumes, sweet clover contains a relatively high percentage of protein, thus making it a source of this valuable constituent of farm feeds. Tables II and III, taken in part from Henry's "Feeds and Feeding," show the relative composition of several different kinds of feed.

TABLE II.—*Average percentage composition of sweet clover and other forage feeds and value of same per ton.*

Kind of forage.	Number of analyses.	Water.	Ash.	Protein.	Crude fiber.	Nitrogen-free extract.	Ether extract (fat).
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Fresh sweet clover	7	77.0	1.8	3.9	6.9	9.4	0.6
Fresh alfalfa	23	71.8	2.7	4.8	7.4	12.3	1.0
Fresh red clover	43	70.8	2.1	4.4	8.1	13.5	1.1
Sweet-clover hay	6	7.7	7.5	13.3	26.9	42.6	2.1
Alfalfa hay	21	8.4	7.4	14.3	25.0	42.7	2.2
Red-clover hay	38	15.3	6.2	12.3	24.8	38.1	3.3
Timothy hay	68	13.2	4.4	5.9	29.0	45.0	2.5
Cowpea hay	8	10.7	7.5	16.6	20.1	42.2	2.2

TABLE III.—*Digestible nutrients in sweet clover and other forage crops and feeds and value of same per ton.*

Kind of forage or feed.	Dry matter in 100 pounds.	Digestible nutrients in 100 pounds.			Value per ton of feed.
		Protein.	Carbohydrates.	Ether extract.	
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	
Sweet-clover hay	92.4	9.9	38.1	1.2	$18.49
Alfalfa hay	91.6	11.0	39.6	1.2	20.16
Red-clover hay	84.7	6.8	35.8	1.7	14.12
Timothy hay	86.8	2.6	43.4	1.4	9.80
Cowpea hay	89.3	10.8	38.6	1.1	19.76
Wheat bran	88.1	12.2	39.2	2.7	22.80
Shelled corn	89.1	7.9	66.7	4.3	20.16

The values per pound assigned as the basis of calculation of the value of the digestible nutrients in a ton of the feed as given in Table III are protein, $0.0674; carbohydrates (starches, etc.), $0.0064; ether extract (fats), $0.0112. These figures are merely relative, as the prices of the food elements vary in different sections of the country and from year to year. It will be noted that the value of sweet-clover hay on the above basis would be almost double that of timothy and intermediate between red clover and alfalfa, and that the actual market prices of the different feeds bear little relation to their theoretical value.

FEEDING EXPERIMENTS WITH SWEET CLOVER.

A great many farmers have reported successful experiments in feeding sweet clover to live stock, but relatively few of the experiment stations have performed definite feeding experiments to determine the exact value of sweet-clover hay as compared with other crops. The Wyoming Experiment Station, however, performed an interesting experiment with lambs. A number of pens of from 10 to 40 lambs each were each fed different mixtures of feeds for a period of two weeks. Those receiving sweet-clover hay, corn, and a small amount of oil meal made an average gain of 30.7 pounds per head as compared with 20.3 pounds for those receiving native grass hay, oats, and oil meal. Those receiving alfalfa and corn made a gain of 34.4 pounds per head. The details of the experiment with four of the pens of lambs are given in Table IV.

TABLE IV.—*Showing results of feeding tests with lambs.*

Ration.	Number of lambs.	Average gain per head in pounds for 14 days.	Pounds of feed required for 100 pounds of gain.					
			Sweet-clover hay.	Native hay.	Alfalfa hay	Corn.	Oats.	Oil meal (old process).
Sweet-clover hay, corn, oil meal	10	30.7	637.5	.....	.....	293.2	.....	20.5
Native grass hay, oats, oil meal	40	20.3	.....	606.7	.....	.....	460.5	25.0
Alfalfa hay, corn	10	34.4	.....	.....	557.7	261.6	.....	.....
Do	40	34.3	.....	.....	557.3	286.5	.....	.....

The sweet-clover hay used in this experiment was stated to be stemmy in its nature and more than a year old. It is of interest to know that in spite of its stemminess the hay was eaten up close by the lambs.

At the Iowa Agricultural College a grazing experiment with young shoats was made comparing sweet clover and red clover. The details of this experiment are shown in Table V.

TABLE V.—*Comparative results of pasturing pigs on sweet clover and on red clover.*

Kind of pasture.	Number of pigs per acre of pasture.	Daily gain per head.	Gain for entire lot per acre.	Grain required for 100 pounds of gain (in addition to pasturage).
		Pounds.	*Pounds.*	*Pounds.*
Sweet clover	18	1.02	2,594	338
Red clover	15	1.13	2,394	333

The results of these technical experiments are thoroughly substantiated by numerous private feeding tests in various sections of the country. Hundreds of fat cattle which have been fed almost exclusively on sweet-clover hay as a roughage in central Utah are marketed annually. From certain sections of western Iowa steers have been turned off fat from sweet-clover pasture and have brought $1 per hundredweight premium over the ordinary grass-pastured stock marketed at Chicago from the same locality.

In a feeding experiment with sheep conducted by two students at the Iowa Agricultural College it was found that the protein digested in sweet clover fed alone was 69 per cent, and that the addition of corn to the hay ration increased the digestibility of sweet clover to 82 per cent. (See Table VI.) Alfalfa and red clover showed similar increases in the digestibility of their protein content when corn was added to the ration. The percentage of digestibility figured for the

protein in the corn was the average of a number of digestion experiments. The probability is that the digestibility of the corn was also increased by the presence of the hay in the ration, so that not all the increase in the digestibility should be credited to the hay constituents of the different rations.

TABLE VI.—*Comparative percentage digestible of protein and of dry matter in sweet clover, in alfalfa, and in red clover.*

Ration.	Percentage digestible.	
	Protein.	Dry matter.
Sweet clover:		
When fed alone	69	52
When fed with corn	82	74
Alfalfa:		
When fed alone	70	61
When fed with corn	83	75
Red clover:		
When fed alone	46	49
When fed with corn	61	61

SWEET CLOVER AS A SOIL IMPROVER.

One of the most valuable qualities of sweet clover is its ability to improve the soil on which it grows. This it does in part by reason of its large roots, which break up the lower layers of the soil and by their rapid decay add a great deal of humus to the layers which lie below the usual depths of plowing (fig. 4). In addition to this the stubble and stems when plowed under add a good deal of humus to the soil. Its most important characteristic is the ability, which it enjoys in common with other legumes, of fixing nitrogen by means of the nitrogen-gathering bacteria which live in the tubercles on the roots of the plant. This ability enables it to add much nitrogen, a most costly fertilizer, to the soil in which it grows. Many legumes require considerable humus in the soil for anything like a good growth, but sweet clover seems to be a notable exception to this rule and will generally thrive where this usually essential factor is absent. The ability to thrive in such locations makes it especially valuable as a pioneer crop on poor, run-down, badly washed fields such as exist in parts of the Southern States, especially in limestone sections. Its ability to succeed on similar fields outside the limestone section has not yet been fully determined. As an instance of its effect on land it may be mentioned that in Alabama on poor, run-down soil it produced 6,672 pounds of hay per acre the first year and 7,048 pounds the second year, after which the stubble was plowed under and planted to corn. The corn produced 22.7 bushels per acre as compared with 16.2 bushels per acre upon an adjoining plat where sweet clover had not been grown. The year following a similar experiment

in the same section showed the corn to have yielded 28.2 bushels on the sweet-clover stubble land as compared with 21.2 bushels where cotton instead of the sweet clover preceded the corn. A total of 11,376 pounds of hay had been cut from the sweet-clover plats during its two seasons of growth.

At the Ohio Experiment Station sweet-clover land gave a yield of 26.9 bushels of corn, as compared with 18.6 bushels on similar land not in sweet clover the previous year. An experiment performed at Tost, Germany, showed that sweet clover preceding oats increased the yield of oats 17 bushels per acre. Part of the field was devoted to potatoes, with the result that the yield was more than doubled when compared with an adjoining plat not previously seeded to sweet clover. Some idea as to the large amount of green material which sweet clover provides for soil improvement is shown by a report from the Ontario Experiment Station in the cutting of over 30 tons of green fodder per acre, as compared with 13½ tons for mammoth clover, which stood next in rank.

Sweet clover has given excellent results in improving the texture of sandy lands and gumbo soils which are too stiff to otherwise produce satisfactory crops. Its effect on gumbo and adobe soils is in part an aid to drainage in that its large succulent roots do much toward loosening up the texture of the hardpan subsoil. In the West it has shown itself able to grow on soil so strongly impregnated with alkali that little else than the salt-grass among the native plants can exist. After a crop of sweet clover has been grown on such soil it is usually possible to grow some other field crop.

SWEET CLOVER IN ROTATIONS.

Being a biennial, sweet clover lends itself readily to short rotations. In this respect it is similar to red clover. Its demand for a very firm seed bed makes it less easy to obtain a stand on cultivated fields than is usually the case with the red clover.

When used in the semiarid regions in rotations with small grain it has failed to give as good results as rye or some other crop used for green manure, on account of its effect on the soil moisture. It is usually not ready for plowing under as early in the season as rye and thus a shorter time for the moisture-conserving fallow is allowed.[1] This disadvantage might be obviated to some extent by following the sweet clover with corn, which does not require so much soil moisture early in the season. In the East where these conditions of light rainfall do not exist it is not so essential that a corn crop follow the sweet clover.

[1] See Bulletin 187, Bureau of Plant Industry, entitled "A Study of Cultivation Methods and Crop Rotations for the Great Plains Area," by E. C. Chilcott.

ERADICATION OF SWEET CLOVER.

The fear is often expressed that sweet clover will escape and prove a troublesome weed if it is seeded on the farm in one of the regular rotations. In answering this objection it may be stated that in the sections where sweet clover has been most utilized it is almost universally held that no difficulty is experienced in ridding a field of sweet clover when it is desired to follow it with some other crop. In the South one year in corn or cotton will usually remove all but an occasional trace of the sweet-clover plants. Being a biennial it is only necessary to prevent its seeding for two years and the stand is destroyed with the possible exception of plants from some "hard" seed which failed to germinate the first or second season and which may come up occasionally in later seasons. The fact that it makes no seed the first season and seeds only the second season insures its being destroyed in cornfields and other clean cultivated fields before it has an opportunity to produce seed. In grain fields it need not be feared, since the plowing necessary for the grain crop will turn under before they have seeded any plants which have started. It perseveres as a weed only in those places which are not completely cultivated at intervals of two years or less. Even in these places it is not wholly undesirable, since some vegetation is almost sure to occupy such places and other vegetation would presumably furnish less sustenance for bees, nor is other vegetation apt to be so efficient in building up such waste places and increasing their fertility.

Its control becomes especially difficult only in irrigated localities where the old plants along the ditch banks furnish a crop of seed which is scattered over the land by the irrigating water each year. The only way to prevent such an occurrence is to keep the plants cut off along the ditches.

SEED PRODUCTION OF SWEET CLOVER.

In most parts of this country the seed production of sweet clover is still in a rather primitive state. It is the common practice in the South to cut the plants when damp, place them in convenient piles, and later flail off the hulls on canvas with sticks or beaters. The seed so obtained is generally sold in the hulls, although they may be readily removed by the use of a clover huller. The unthrashed hay is rather too coarse to run easily through a huller, but the difficulty can be avoided by thrashing the seed first and then hulling it. Imported seed is generally hulled, while native-grown seed is apt to be sold in the hull just as it comes from the flail or thrashing machine, but with the trash and leaves mostly removed. The seed shatters very easily, and great care must be taken to avoid losing a large proportion of it while harvesting. The largest yields of seed come from stands

not too thick and which have not first been cut for hay, although satisfactory seed crops have usually been obtained from fields which have produced one crop of hay in the North and two in the South when the rainfall is sufficient (figs. 10 and 15). Care should be taken to cut the stubble of the preceding hay crops rather high, so there may be ample room for new shoots, as the plants do not readily form new crown shoots, as alfalfa does. When flailed out the straw may be returned to the field to be plowed under for fertilizer. It should preferably be applied to any gulleys which may be in the field and thus stop the washing. The straw is also used as a winter feed for cattle.

ENEMIES OF SWEET CLOVER.

Sweet clover appears to be remarkably free from enemies of all kinds, including insect pests, parasitic plant diseases, burrowing rodents, or other similar animals. It is possible when it becomes more generally utilized as a field crop that injurious enemies will be recognized, but at present there appears to be no immediate danger from any that have been reported. A few parasitic plant diseases occasionally occur on the growing plants, but they are not usually troublesome. Among insects an aphis (*Aphis medicaginis* Koch) has at times proved injurious to the sweet-clover plants.

SWEET-CLOVER PRODUCTION IN DIFFERENT SECTIONS OF THE UNITED STATES.

In a number of different sections of the United States the early opposition to sweet clover has been overcome, and this plant is now well established as a regular farm crop and recognized as a valuable addition to the list of available crops for forage purposes, for green manure, and for soil improvement. The methods of handling this crop vary to some extent in these different sections.

SWEET CLOVER IN MISSISSIPPI AND ALABAMA.

Sweet clover appears to be especially well adapted to the black prairie soils of northwestern Mississippi and central and western Alabama. In this section it is found chiefly on the limestone hills and knolls where the soil is thin and poor in humus. On these soils it is utilized as pasturage or as hay for two or more years, after which the ground is usually in condition for the raising of profitable crops of corn or cotton. Before the extension of alfalfa on the lower lying fields in the black prairie section the use of sweet clover was common on such soils, but with the introduction of alfalfa culture on these better soils sweet clover has been sown more on the hilly lands. In addition to furnishing pasture and green manure it is

also efficient in arresting the washing on hilly fields. It may be cut for hay once or twice the first season and three times the second season. It is also valuable for renovating canebrake fields and is the earliest pasture available. When seeded on thin soil of limestone origin it succeeds as perhaps no other crop will, and in three years deepens the soil to such an extent that other crops may be profitably produced. It is seeded very early in the spring either alone or with oats as a nurse crop. So far as known it has not spread to any considerable extent on the clay soils immediately adjoining the limestone lands, although it now grows naturally on much of the limestone lands. The division line between the two soil types is exceedingly sharp in many places in this section, and the absence of the sweet clover from the clay soils when it is so abundant a few feet

FIG. 12.—Sweet clover arresting erosion in a gullied field in Kentucky. The 1-year-old plants reach the knees of the figure in the foreground.

away has been the occasion of considerable comment. It is utilized as a feed for horses, mules, and cattle both as pasturage and as hay.

SWEET CLOVER IN KENTUCKY.

On the limestone hills of northern Kentucky sweet clover is proving to be a very valuable plant in restoring the old-time productivity of the soils. A decade ago many farms were coming to be abandoned, owing to their low productive capacity. Many of the fields contained gullies which washed, making the farms even less valuable. Sweet clover was introduced as a bee plant in some of the waste places in this section and proved so efficient as a soil improver that it has been largely utilized on a great many farms in this section.

Figure 12 indicates the method by which it stopped the gullies, which were rapidly ruining the field. Figure 13 illustrates a cornfield on the ordinary soil of this section, while figure 14 represents a cornfield on land which a few years before was too poor to grow anything but sweet clover. As a result of the introduction of sweet clover many of these farms are no longer abandoned but are producing satisfactory incomes for those who are working them. The fields are utilized as pastures and for hay while the soil is being built up and the gullies stopped from washing (fig. 12). When the process of natural reclamation has gone far enough the ground is plowed and put into corn.

FIG. 13.—Scene on a nearly worn-out farm in northern Kentucky. Corn almost a total failure.

SWEET CLOVER IN UTAH.

Sweet clover has been grown for a number of years in Utah in the irrigated sections surrounding Ferron in the central part of the State. This locality is noted for the production of alfalfa seed, and a large percentage of the agricultural land of that community is devoted to this crop. The soil for the most part is rather poor in the beginning, and it has been found that sweet clover will put the soil in condition for alfalfa sooner than any other treatment available. At the same time it furnishes forage for cattle and horses which is practically equal in feeding value to the alfalfa. Most of the farmers around Ferron have had more or less experience with the growing of sweet clover and a large number are enthusiastic advocates of it as a means of increasing the value of their land and putting it in condition to seed to alfalfa. The soil is derived largely from the disintegration of slaty shale and seems to be well adapted to

the production of sweet clover. No artificial inoculation is needed, and under irrigation it yields as much as 5 tons of hay per acre. The general practice is to seed the sweet clover with a grain crop in the spring; then after harvesting the grain crop the sweet clover can be pastured during the remainder of the summer and autumn. The following season two full crops of hay may be cut. It is usually plowed up the second season and followed with a crop of oats or wheat. The dairy farmers around Ferron are practically unanimous in the opinion that sweet-clover hay will produce as much or more milk than alfalfa, and it is also very highly prized for feeding horses during the winter. The principal objection to its more extended use is the difficulty which is encountered in curing the hay. The general practice is to bunch it while yet quite green and allow it to cure in the shock (fig. 15). This requires that it remain shocked for at least one week, and then care must be used in hauling and stacking to avoid shattering the leaves.

FIG. 14.—View of a cornfield where sweet clover was previously grown. This field is about one mile from the scene shown in figure 13.

The farmers in most of the other irrigated districts of Utah do not seem to have appreciated the value of sweet clover, and in many localities it is considered a pest, growing vigorously along the irrigation ditches and scattering from these vantage points over the remainder of the field, being carried by the irrigation water.

SWEET CLOVER IN COLORADO AND WYOMING.

Extensive areas in the irrigated districts of Colorado and Wyoming have become seeded to sweet clover, but as yet it is regarded largely as a weed and little use seems to be made of it either as hay or as pasture. It is found mostly in localities where seepage has made the land useless for other crops. In such places it grows vigorously and occupies the ground to the exclusion of other less

valuable plants. The farmers are anxious to make use of it as a crop, but as yet few have investigated the subject sufficiently to understand its importance as a crop available for use on those parts of their farms which would otherwise be unproductive.

The Wyoming Agricultural Experiment Station has conducted feeding experiments with sheep which have demonstrated fully its value for this class of live stock; still, very few sheep owners are seeding sweet clover on their waste lands or making any consistent effort to increase its acreage throughout the State.

FIG. 15.—Sweet clover in shocks ready for the seed huller.

SWEET CLOVER IN NEBRASKA.

Scattered fields of sweet clover are to be found throughout Nebraska, but no continuous and consistent use of it has occurred in any part of the State. In the eastern part of the sandhill district a number of settlers have seeded it on their sandy soil and have been very well pleased with the results obtained in improvement of their pasture land and in the hay obtained therefrom (fig. 16). When seeded in the "blowouts" which often occur in the sandhill district it has held on tenaciously, reseeding itself at the end of its growing period. Its greatest value to this locality probably arises from the improvement of the soil, but a number of the settlers have found it much better than the native hay for feeding stock. Its growing popularity is evidenced by a recent statement of the manager of a large ranch in the eastern part of the sandhill district of Nebraska, that the ranch owners were expecting to seed on their ranches an area requiring a ton of sweet-clover seed.

SWEET CLOVER IN THE NORTH-CENTRAL STATES (IOWA, WISCONSIN, ILLINOIS, INDIANA, OHIO, AND MICHIGAN).

In the North-Central States the somewhat isolated places where sweet clover has been grown are sufficiently numerous to indicate that it is widely adapted and could be much more widely utilized than it is at present. Its successes are sufficiently numerous to indicate that they are not due to any particular soil or climatic conditions. In these sections one crop of hay the first season and a crop of hay and also a crop of seed the second season are possibilities. Spring seeding is generally recommended, and this may either be alone or with grain as a nurse crop. Throughout this section sweet clover must compete with red clover, alsike clover, and alfalfa. It

FIG. 16.—Sweet clover growing in practically pure sand in western Nebraska.

is not yet to be recommended where these crops grow successfully, for the present at least, so it is best to utilize it under conditions where these more valuable forage plants can not be successfully produced.

SUMMARY AND CONCLUSIONS.

The data at hand indicate that when properly handled sweet clover is a valuable addition to the farm crops of many sections.

It is efficient as a soil renovator, by reason of the large amount of nitrogen it is able to take from the air as well as the humus added to the soil when it is turned under or from the decay of roots when the crop is harvested.

Sweet clover will grow on soils too low in humus content for the favorable growth of most other legumes.

Its large roots, which develop the first year, facilitate drainage and do much to break up and improve the tilth of the soils which lie below the reach of the plow, as these roots rapidly decay when the plant dies, and their effect is therefore almost immediate.

Sweet clover occurs as a weed usually along roadsides, in vacant lots, in fence corners, along irrigation ditches, and in other places not utilized or cultivated.

It is not troublesome in cultivated fields or meadows as ordinarily treated, because it can not persevere more than two years from one seeding.

The presence of some hard seed which does not usually germinate the first season may enable it to continue in a meadow for a number of years longer.

Sweet clover can usually be killed by mowing when in full or late bloom.

It is regarded as a pest in irrigated fields of the West, where the irrigating water carries in the seed from scattered plants which quite commonly grow along the ditch banks.

In irrigated sections where alfalfa succeeds well, the introduction of sweet clover is not to be recommended.

The presence of sweet clover on otherwise bare soils, even as a weed, is not necessarily to be condemned, as it is building up the soil in both humus and nitrogen content and is thus preparing it for subsequent profitable crops.

The great numbers of failures in obtaining a stand of sweet clover are due in part to the high percentage of hard seed and in part to seeding on too loose a seed bed, especially when combined with a lack of inoculation.

Spring seedings in general are satisfactory, but in the South excellent stands are also obtained from late winter seedings. The latter method may prove generally applicable wherever there is abundant rainfall.

Analyses and feeding experiments indicate that it is nearly equal to alfalfa in feeding value.

The feeding value, palatability, and presumably the digestibility decrease rapidly after the blooming period.

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